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A Contribution to the Vertebrate Paleontology of Brazil. By E. D. Cope.

(*Read before the American Philosophical Society, April 17, 1885.*)

Professor Orville A. Derby, Director of the Geological Section of the National Museum of Brazil, has desired me to furnish to the museum an account of the extinct Vertebrata from the various strata found within the limits of the Empire, which are preserved in the Museo Nacional at Rio de Janeiro. I have also received a considerable collection made in the neighborhood of Bahia by Mr. Joseph Mawson, of London, England, which has aided me much in the determination of the extinct fauna of that region.

The horizons from which the species now enumerated have been derived are the Pliocene, the Cretaceous and the Carboniferous. The work hitherto done in this field is small in amount. The researches of Lund and Reinhardt into the fossils of the caves of Brazil are well known. Professor Owen has determined the existence of Crocodilia and Dinosauria in the Cretaceous beds near Bahia; and Professor Marsh has described a gavial from the same horizon and locality. Professor J. S. Newberry has identified some fishes from Ceara in Eastern Brazil as of Jurassic age; and I have described a genus and species from the same locality. In more detail, the localities and horizons from which the specimens of vertebrate fossils of the Museo Nacional have been derived, are the following, so far as determined:

PLIOCENE, *Pampean.*

North-eastern pt. of Province of Bahia; *Toxodon expansidens*, sp. nov.

CRETACEOUS ? *Laramie.* Near Bahia. *Diplomystus longicostatus*, sp. nov. *Chiromystus mawsoni*, sp. nov.

Fox Hills. Province of Pernambuco. *Hyposaurus derbianus*, sp. nov.;

Enchodus subæquilateralis, sp. nov.; *Galeocerdo pristodontus* Agass.; *Apocopodon sericeus*, sp. nov.

?————. Province of Sergipe del Rey. *Pycnodus flabellatus*, sp. nov.

JURASSIC. Province of Ceara. *Anædopogon tenuidens* Cope. *Aspidorhynchus*, sp.

CARBONIFEROUS. Province of San Paolo. *Stereosternum tumidum*, sp. nov.

The following pages contain the detailed descriptions of the new species, and the determination of their affinities. Others yet remain to be determined.

PISCES.

APOCOPODON SERICEUS, gen. et sp. nov. Myliobatidorum.

Char. gen. Founded on teeth which formed a pavement like that of Myliobatis, but which are mostly separated in the specimen. These consist of longer ones of a median series, and smaller ones of the lateral series. The teeth of the median series are shorter than in the typical forms referred to Myliobatis, having rather the proportions characteristic of Zygobatis. They differ from the corresponding teeth in both genera in being exactly parallelogrammic in outline; that is, the extremities are truncated instead of angulated as in those genera.* The lateral teeth display the usual angulation among themselves, though doubtless joined by a straight suture to the middle row. The roots are well distinguished from the crowns, and are short. Their grooves are very shallow, or merely indicated. The triturating surface is covered by a dense layer which is wrinkled like the sides of the crown, and is continuous with it.

Char. specif. The teeth are robust and indicate a species of considerable size. The crowns are considerably more elevated than the roots, and have perpendicular sides. The sutural surfaces are straight, and marked by fine grooving which runs at right angles to the grinding face, and is continuous with the wrinkling of the latter on the long sides of the crown. From this it follows that the wrinkling crosses the grinding face at right angles to its long diameter. There are in the wrinkling six ridges to a millimeter. The roots are constricted from the crowns by a groove, which is itself divided by a narrow collar-like rib, resembling cement, which is expressed on the junction of two pieces by pressure, grown cold. The sizes of the teeth diminish externally. The roots of those of the antepenultimate are crossed by four shallow grooves, and those of the penultimate by two. External row lost. Six grooves cross the root of one of the larger teeth.

Measurements.		M.
Diameters of larger tooth	transverse	.024
	anteroposterior	.013
	vertical	.021
Vertical diameter of root of do		.006

*One end of one of the large teeth has the usual two faces.

Measurements.		M.
Diameters of root of antepenult tooth	transverse	.015
	anteroposterior	.010
Diam. of root of penultimate of row	transverse	.007
	anteroposterior	.010

From Maria Farinha, Province of Pernambuco. Probably of Fox Hills or Maestrichtian Cretaceous age. Coll., No. 306.

ENCHODUS SUBÆQUILATERALIS, sp. nov.

This species is represented by a premaxillary bone bearing the long laniary tooth characteristic of the genus, and by another osseous fragment bearing a similar tooth, which may perhaps belong to the distal part of the dentary bone. I describe the first-named specimen. The fragment of the premaxillary is so small that little can be said of it, except that its surface is smooth, and but slightly convex, and that it projects but little beyond the long tooth. The tooth is long and slender, and has a very slight sigmoid fore and aft curvature. It has two opposite cutting edges, the anterior of which reaches to its base, and the posterior for half of its length. The inner face of the tooth begins to be more convex than the external at about the middle of its length, but this convexity is not much marked beyond the basal fourth. The surface of the tooth is smooth everywhere.

This species is readily distinguished from such species as *E. mortoni*, where the edges are not opposite. From the *E. carinatus* and *E. gladiolus*, where the edges are opposite, the smooth surface separates it. In the allied *E. dolichus*,* the posterior cutting edge only extends one-quarter the length of the tooth.

Length of crown M. .022; diameters at middle, long, .004; short, .0023.

DIPLOMYSTUS LONGICOSTATUS, sp. nov.

This herring is represented by numerous specimens, and possesses well-marked characters. These may be stated in general thus: The caudal part of the vertebral column is very short. The abdomen is very deep and the ribs are long. The caudal fin is deeply forked, and has long acute lobes. The other fins are very small.

The scales are so attenuated as not to be countable. The scutes of the median dorsal line are longer than wide, and are emarginate behind, and hence cordate. The superior surface of two of them is roughened with radiating ridges. The inferior surfaces are smooth. None behind the dorsal fin.

The dorsal outline rises gradually to the dorsal fin, and then gradually descends to the caudal peduncle. The general convexity is slight. On the other hand the abdominal convexity is very great, and is especially protuberant below the dorsal fin. The depth at this point enters the total length, minus the caudal fin, one and five-sixth times. The length of the head enters the same three times. The superior surface of the head

*See Report on Cretaceous Vertebrata of the West, E. D. Cope, p. 300.

slopes gently from the dorsal line; hence the pectoral outline is very steep. The head is a good deal injured in the typical specimen, but it is somewhat longer than deep.

The middle of the base of the pectoral fin is half-way between the vertebral column and pectoral border inclusive. The dorsal fin begins along the anterior border of the fourteenth vertebra. It is elevated in front, and, having a short base, has a rapidly descending posterior outline. The anal fin originates much behind the posterior border of the dorsal. It is also short and weak. Formula, D. 10; C. + 18 +; A. 8. Vertebræ, Abd. 24; C. 10; only one included between the external caudal rays. Neural and hæmal spines weak and rather short. Ribs long and robust. Abdominal scuta rather large, and with a free posterior accumination. The supplementary ribs, if they ever existed, are not preserved. Ventral fins lost from the typical specimen.

Measurements.	M.
Total length (axial)	.126
Length to basis of caudal fin	.096
Depth at free edge of operculum	.044
" " " " " dorsal 1st ray	.055
" " " " " anal " "	.020
Length of dorsal fin { in front	.016
Length of dorsal fin { on base	.014
Length of anal fin { in front	.007
Length of anal fin { on base	.010
Length of a caudal lobe from base	.035
" " abdominal vertebræ	.056
" " caudal "	.020

The specimens are from the coast near Bahia. The type comes from near Itacaranha, where it was found by Mr. Joseph Mawson. Other specimens are from the same locality, while others are from Plataforma and Agua Comprida. In none but the type do I find the dorsal scuta preserved.

This genus has hitherto been only known from the Lower lacustrine Eocene of North America. Its occurrence in this supposed marine formation indicates that, like its close ally *Clupea*, *Diplomystus* has considerable range in time and space. The *D. longicostatus* falls into the section of the genus represented by *D. humilis* Leidy. From this and the allied *D. altus*, it differs in the more numerous abdominal and less numerous caudal vertebræ, and the longer lobed more deeply furcate caudal fin.

CHIROMYSTUS MAWSONI, gen. et sp. nov.

This new genus and species are indicated by a single large specimen from the same horizon as the *Diplomystus longicostatus*. It is nearly complete, with the important exception that the head and a few anterior dorsal vertebræ are wanting. The impression of the scapular arch, however, gives the position of the skull, and the anterior ribs give a clue to the

character of the anterior dorsal vertebræ. From these it appears that the genus is Isospondylous and not Plectospondylous.

Char. gen. Dorsal fin small, above the anal, which is moderate. Pectoral fin with several superior rays thickened and robust. Caudal fin furcate. Ventrals small. No ventral or dorsal scuta. Scales much attenuated. No basilar interneurals or hæmals.

This genus may belong either to the *Hyodontidæ* or *Chirocentridæ* so far as the characters given by authors are concerned, since the only distinctions given are found in the soft parts. I have pointed out * that the parietals are in contact, and the caudal fin embraces two vertebræ in the *Hyodontidæ*, while in the *Chirocentridæ* the parietals are separated by the supra-occipital, and there is but one caudal-fin vertebra as in the *Clupeidæ*. I can only observe the caudal fin in *Chiromystus*, and find that it includes two vertebræ, as in the *Hyodontidæ*.

Char. specif. The form is rather elongate. The depth of the longest ribs, and vertebra corresponding, enter the length, exclusive of the head and caudal fin, four and a third times. Vertebræ, Abd. 28 ; C. 22. The anterior dorsals are obtained by counting the ribs, and three are added to the caudals visible, in order to fill up an interruption caused by fracture. The centra are longer than deep, and have two lateral longitudinal fossæ, bounded above and below by a narrow rib, and separated by a flattened rib.

The posterior part and apex of the dorsal fin are wanting, so that its characters cannot be given, except by stating that the rays are slender and weak. The anal fin is injured at its posterior extremity, but by counting the interhæmal bones I find the rays to number sixteen. The four superior pectoral rays are very robust, the inferior most so. The three upper are preserved, and it can be seen that they are compressed and smooth, and not segmented. The caudal fin is very deeply forked, and the lobes are long. Each one consists of six strong external rays, besides the fulcral rays, and a number of very fine rays on the inner side of these, giving each lobe a narrow form. The scales are extremely attenuated, and cannot be counted. The ventral fins are quite small, and the rays may not all be preserved, although those that are visible are in place. They number only four.

Measurements.	M.
Length of vertebral column	.310
" " a lobe of the caudal fin	.100
" from base of ventral to base anal	.081
" " " " anal to base caudal	.085
" " " " dorsal to base caudal	.063
" superior spine pectoral fin	.065
" of ventral fin	.027
Diameters of last abdominal vertebra { longitudinal	.008
Diameters of last abdominal vertebra { vertical	.0075

* Proceedings Amer. Assoc. Adv. Sci., Vol. xx, p. 333.

The specimen was obtained near Agua Comprida, near Bahia, by Mr. Joseph Mawson. I dedicate the species to him with much pleasure, in recognition of the valuable service rendered by his collection in the present investigation.

PYCNODUS FLABELLATUS, sp. nov.

A slab of limestone contains a skeleton of this fish, but the latter is in several points imperfect. The head anterior to the orbit is wanting, and the superior half of the anterior dorsal region is broken away. The ventral fins are lost. Some isolated teeth are of the proper size to belong to this species, and will be mentioned later.

The outline of the profile of the body is discoidal, and the axis of the skull (vomer, etc.) is directed obliquely downwards at an obtuse angle with the vertebral column. This requires an extensive production of the operculum above and posterior to its articulation with the hyomandibular. The clavicle is slender, while the coracoid is produced backwards below the pectoral fin, its superior border being concave to the first rib, which is overlapped by the posterior edge. The coracoid also extends downwards and forwards as usual. The four basilar bones of the pectoral fin are rod-like, and are moderately expanded distally. The determination of this point is of much importance in fixing the position of the *Pycnodontidæ* in the system. The basis of the dorsal and ventral fins descend steeply downwards to a narrow and very short caudal peduncle. The caudal fin is of characteristic form. Its lobes are long, but they diverge so widely that the posterior edge of the fin is slightly convex from tip to tip. Radii, D. 53 ; C. 3 + 40 + 2 ; A. 24.

The constitution of the vertebral column is not easy to make out. Only the anterior half is preserved. This displays the usual superior and inferior plates. In the present species the edges of these are in contact, so that the condition of the centrum, if there be any, as to ossification, is not positively determinable. The neural spines above their basal expansions are connected by a series of longitudinal teeth which interlock closely so as to resemble a series of ribs. On examination it is found that half of these originate from one neural arch, and half from the other, there being six or seven in all. A slight protuberance, probably for the rib-head, appears 3 mm. below them. The true ribs are broadly alate, so as to form a continuous wall. The rhabdopleurs agree in number with the vertebræ, and are present to the end of the vertical fins. On the caudal region they extend downwards .66 the length of the hæmal spines. The latter extend to the superior apices of the interhæmals. The rhabdopleurs are not segmented as is represented in some species of this family. The caudal fin includes one or two vertebræ. There are two short, widely expanded hypurals, much as in *Physoclystous* fishes where they are distinct. Vertebræ, D. 19 ; C. 15 or 16.

Measurements.	M.
Total length to anterior edge of orbit	.172
Longitudinal diameter of orbit	.016

Measurements.	M.
Distance from orbit to free edge of operculum	.022
Length of vertebral column	.116
Diameters of caudal fin { anteroposterior	.027
Diameters of caudal fin { vertical	.093
Depth above rib-heads at front of dorsal fin	.055
" below hæmal plates, front of anal fin	.044

The teeth preserved are loose medians, and perhaps laterals, but the reference of the latter is uncertain. The crowns of the former are a little more than twice as wide as long, and have the extremities a little oblique. The summit is a little flattened, and the sides project a little beyond the base. The surface smooth. Length, M. .010 ; width, .0045.

The peculiar form of the caudal fin distinguishes this species from most of the known members of the family *Pycnodontidæ*. The feeble dorsal and anal fins distinguish it from others, and the discoidal form from still others.

The structural characters observed in the specimen described have been instructive, especially those of the pectoral fin. These confirm altogether my reference of the family of the *Pycnodontidæ* to the *Isospondyli* as distinguished from the *Halecomorphi.**

The typical and only specimen of this species in the collection is from the southern centre of the Province of Sergipe del Rey. It is on a slab of cream-colored calcareous rock which has a coarse slaty cleavage, and probably belongs to the Cretaceous formation, and is of marine origin.

? BATRACHIA.

STEREOSTERNUM TUMIDUM, gen. et sp. nov.

Char. gen., etc. This genus is known from numerous vertebræ and ribs, sometimes forming consecutive series, but more frequently isolated ; but especially from two slabs, which exhibit the posterior part of a skeleton ; *i. e.*, dorsal vertebræ and ribs, pelvis and posterior limbs, and caudal vertebræ.

The dorsal vertebræ present some of the general characters of the reptiles and batrachians of the Permian period. One of these is the existence of a notochordal canal. The small size of the vertebral centrum as compared with the arch and its appendages constitutes a resemblance to the batrachian class ; as also do the horizontal position and weak development of the zygapophyses. On the other hand the simple articulation of the ribs resembles that of the Lacertilia in general, though not of any known group of that order ; and has no resemblance to any known reptile of the Carboniferous period.

The vertebral articular surfaces are both funnel-shaped, the anterior deeply, the posterior shallowly excavated. The dorsal centra are undi-

* On the classification of the Extinct Fishes of the Lower Types. Proceeds. Amer. Assoc. Adv. Science, 1878, p. 292.

vided, and the notochordal canal is small. The caudal vertebræ have a groove, more or less obliterated by coösification, surrounding the middle of the centrum, and cutting off a part of the base of the neural spine above. This looks as though the genus possesses intercentra, which were primitively separated by the protovertebral fissure. The posterior part of the centrum carries chevron bones, which are distinct from it. Besides the zygapophyses, there is, in the dorsal vertebræ, a modified form of zygosphen, though there is no zygantrum. The former consists of a roof-like projection of the neural arch above each prezygapophysis, which is applied to the superior surface of the postzygapophyses. In some of the vertebræ, this zygosphenal roof is horizontal; in others it is slightly oblique, rising outwards on each side, in the manner of a true zygosphen. It differs further from a true zygosphen in being fissured vertically, above the neural arch, but there is no corresponding process of the adjacent vertebra to occupy it. On the contrary there is a corresponding fossa of the posterior side of the vertebra in front. These fossæ may be points of insertion of ligaments which strengthen an articulation otherwise weak.

The ribs appear to be coössified with the centra, so that it is difficult to say whether they are truly ribs or diapophyses. In one specimen, the proximal ends of the ribs are seen to be expanded, and applied to the centrum so as to embrace it. These expanded extremities are simple and are separated on the median line of the centrum by a narrow space. Others are not so expanded proximally, but contract to their connection with the centrum. In some of the centra each side is produced into a depressed conical apex in the position of a diapophysis. The position of these vertebræ is uncertain. The ribs are long, cylindric, curved and remarkably robust, having characters like those of the genus Ischyrosaurus of the Laramie formation, or of Mesosaurus of Gervais. They could not have had any movement on the vertebræ.

The scapular arch is represented by a coracoid bone, which though isolated, is lying on a slab with numerous remains of this genus. As no other form is represented on the slab, I suppose the coracoid to belong to Stereosternum. It is expanded fore and aft, most so posteriorly, and possesses a supracoracoid foramen. Its internal border presents a deep notch opposite the glenoid cavity.

Portions of several humeri are preserved. They demonstrate either that the head is subround, or that if expanded it is at right angles to the distal end. The latter is perforated near one of its borders by an epicondylar foramen, but whether entepicondylar or ectepicondylar, I cannot ascertain. The opposite foramen is represented by a shallow groove at the distal end of the opposite side. There are no well marked condyles of the humerus.

The head of the femur is truncate and subround, and without trochanter. The shaft is subround and is of considerable length. There are no distinct condyles, but the articular surface is convex anteroposteriorly. The tibia is a stouter bone than the fibula, and its distal extremity is ex-

panded outwards. Its tarsal articular suface forms an acute angle with the long axis of the shaft, presenting outwards. It has besides a slight distal transverse truncation. The fibula has a robust head and is slender distally. The tarsus consists of seven bones. These are a tibiale, an intermedio-centralo-fibulare, and a tarsale corresponding to each of the five metatarsals. There is a foraminal notch on the internal edge of the intermedio-centralo-fibulare, next to the tibiale. The bones of the foot beyond the tarsus are well distinguished from each other. The metatarsals are rather slender, and are considerably longer than the phalanges of the first row. The phalanges are not much shortened, but diminish in length regularly to the end. The ungual phalanges are not preserved in a perfect condition on any of them. The proximal portion remains on the second digit, and it is depressed, offering no indication of a claw. The first toe is not shortened, and appears to be longer than the second. Its distal segments are lost. Neither the metatarsals nor the phalanges have distinct condyles, but are truncate in the vertical direction.

Abdominal protective armature is present in the form of osseous rods. Several of these rods form a single girdle. They are not connected with the ribs.

The pelvis is partially preserved in the specimen on the slab. Both pubes and ischia are well developed, and if there is any obturator foramen it is very small and median in position. It probably does not exist, but I am precluded from certainty by the condition of the specimen at the point of crossing of the median and transverse sutures. The pubis is not so large as the ischium, and has a foramen near its posterior border. The ilia have less transverse, and greater longitudinal expanse than the pubes, and are in contact on the middle line throughout most of their length.

Affinities. It is not easy to decide as to the position of this genus. While many of its characters are reptilian, some of them are batrachian. Of especial interest in this connection is the structure of the pelvis. Its characters are only like those of some of the Urodele Batrachia, and the Theromorphous Reptilia. It is, however, quite certain that it does not belong to any known family of either class. The vertebræ might be those of a Theromorph reptile, and the pelvis also agrees with that of those animals. The abdominal rods are found in species of that order referred to the genus Theropleura. The ribs and tarsus are however of an entirely different type. The former would refer the genus to the Rhynchocephalia or the Sauropterygia, and there is nothing known in its structure which positively forbids either reference, unless it be the character of the pelvis. It differs from the types of the Batrachia which it most resembles, the Protonopsidæ, in the replacement of the cartilaginous plate which represents the pubis by two osseous plates. It presents a near resemblance in important characters to the genus Ichthycanthus* which

* I refer to the *Ichthycanthus ohiensis* from the description and from memory, as the specimen is not at present accessible. The *I. platypus* is one of the Rhachitomi, and has in the tarsus, astragalus, calcaneum, navicular, and five distinct tarsals of the second row.

I described from specimens procured by Professor Newberry, in the coal measures of Linton, Ohio.* The peculiar structure of the tarsus is identical as to the number of its elements, and the other characters agree in general. There are important differences also, which would refer Ichthycanthus to another family. Thus the dorsal vertebræ have the centra deeper than long, and the ribs are free. In the absence of the skull, it is not possible to be sure as to which of the classes, Reptilia and Batrachia, these genera represent.

Another form presents some important points of resemblance ; that is the genus Mesosaurus of Gervais.† The *M. tenuidens* Gerv. was brought by Verreaux from an undetermined formation of Griqualand, South Africa. The specimen, like that of the *Stereosternum tumidum*, is exposed on a slab, and embraces only the head, neck, thorax and anterior limbs. As the dorsal vertebræ are obscured by matrix the only point in which actual comparison can be made is the ribs. These are quite identical in the two types, but the articulations with the vertebral centra are invisible in the Mesosaurus. There are apparently impressions of abdominal dermal riblets, but they are suspected by Gervais to be the tracks of Annelids. Gervais thinks the skull has but a single condyle. The scapular arch consists of coössified scapula and coracoid, but clavicle, præsternum and sternum are not visible. The coracoid is different in form from that of Stereosternum. The humerus is, on the other hand, almost identical, and the carpus is nearly what one would expect to find in the Brazilian form. There are in the first carpal row, two large bones, and in the second, four small ones.

Habits.—The structure of the limb articulations and those of the elements of the posterior foot show that this was a genus of aquatic habits. The firm attachment of the ribs shows further that this type had no intercostal respiration, but used its sublingual or its abdominal muscles, or both, in the act of inhaling air. We may suppose that in its aquatic habitat it retained air in the lungs for considerable periods, and only respired on reaching the surface of the water ; or later investigation may show that it is branchiate.

Geological position.—The peculiar characters of this form and the difficulty of determining its true position in the system, present an obstacle to the interpretation of its probable geological age. It has a good many resemblances to the suborder Choristodera of the order Rhynchocephalia (represented by the Champsosauridæ). This type first appears in the Laramie or latest Cretaceous, and continues only to the top of the lower Eocene. The order Rhynchocephalia is an unsatisfactory one for geological purposes. It still exists in one genus, the Hatteria of New Zealand, and may have existed in the Trias ; although this is not certain.

Prof. Derby informs me that some specimens of Schizodus have been found in the same beds, and he therefore infers that their age may belong

*Proceedings Amer. Philosoph. Society, 1887, p. 573.
†General Zoölogy and Paleontology.

to the Coal Measures or to the Permian. There is nothing in the characters of the genus Stereosternum to contradict such a supposition. The primitive characters of various parts of the skeleton and the obvious resemblances to Ichthycanthus, add probability to such a view.

Specific characters.—These may be first drawn from the specimen of the slab already alluded to.

The relative length of the body is not certainly known, as it is only partially preserved in the specimens sent by Prof. Derby. To judge from the one above referred to, it has the ordinary proportions of a lacertilian. The hind legs are well developed, as for example in an Iguana. The tail is well developed, but its length is not determinable as the distal portions are lost.

In the slab specimen the dorsal vertebræ are split or otherwise damaged, so that I describe them preferably from other specimens. The few that are well preserved show characters identical with the latter. I derive the following however from the slab specimen. The dorsal vertebræ have the neural spines well developed but not much elevated. In profile their vertical diameter is about equal to their anteroposterior, and the superior border is squarely truncate. They diminish in height posteriorly. The spines are present at the lumbar vertebræ. The shafts of the ribs have a round section. The proximal portions are for a short distance abruptly incurved to the vertebral body. The distal extremity is pointed. The tissue is dense, and there is no medullary cavity. In the lumbar vertebræ the rib is much more slender, and is shorter. It is coössified with the centrum. The caudal vertebræ have strong diapophyses, which are acuminate and depressed. In the anterior caudals they are recurved at the extremity, but shorten rapidly posteriorly and are transverse. In the specimen they are all separated from the centrum by a fissure which appears to be too constant and too regular to be regarded as a fracture. I suspect therefore that the diapophyses are free, and are joined to the centrum by a simple truncate head, which has an outline nearly round. This view is confirmed by the presence on each side of the centrum of the median caudal vertebræ, of a bone which resembles the sesamoids of the feet of Mammalia, which is quite free from the centrum, and is applied longitudinally to its anterior half. It is probably the rudimental diapophysis. The posterior caudals have no diapophyses. The latter are the only ones in the specimen which are well preserved.

The bodies of the caudal vertebræ have a low ridge in the place of the fissure which is seen in some other specimens to divide them into equal anterior and posterior halves. The entire centrum is longer than deep or wide, and is a little deeper than wide in section. The neural arch is divided into two parts by the characters of the surface. The anterior half is swollen and roughened by minute pits, and is separated from the less prominent posterior half by a pair of small fossæ, one above the other. The neural spine stands entirely on the posterior half, and is thus widely removed from the prezygapophysis, which is above the anterior border of

the centrum. The neural spine is slender and rather elevated, and is subcylindric at the base, and has a narrow compressed apex, with rounded extremity. The chevron bones are quite slender.

The shaft of the femur is nearly straight, and its distal half is moderately compressed from before backwards. The tibia is generally flattened. Its interosseous border is shorter than its internal border, and is strongly concave. The internal border is gently convex. The shaft is narrower than the proximal end, which is narrower than the distal end. The fibula has an enlarged subtriangular head. The shaft is gently curved, the concavity being, as in the case of the tibia, on the interosseous side. The intermedio-calcaneum, or, according to Baur's view, the astragalocalcaneum, is much the largest bone of the foot. It has a truncate side in contact with the tibia, and a concave interosscous border. The rest of the outline is convex, with a slight truncation for the fibula, and one between the tibial border and the posterior notch. The greatest extent of the bone is transverse, and the greatest longitudinal diameter is in line with the fibula. The tibiale has a T-shaped outline, but the spaces below the transverse extremity and the shaft are filled to the truncate narrower extremity of the shaft. The wide end also has the angles rounded off. The tarsals of the second row are longitudinal wide ovals, excepting the first, or internal, which is round.

The extremities of the metatarsals are depressed ovals, and are wider than the middle of the shafts. The phalanges are more depressed. The metatarsals and phalanges of the fifth digit are the shortest, and the lengths of these elements steadily increase to the first. The phalanges of the first digit are lost excepting the first; and the ungual phalanges of the third, fourth and fifth are wanting. Adding the latter, we have the following number of phalanges for the digits from the second to the fifth conclusive, 4–4–4–3.

The anterior border of the pubes is concave, leaving a lateral convex border in front of the acetabulum. The pubes of opposite sides meet at an entrant right-angle. The external posterior angles of the ischia are rounded and prominent, since the posterior borders are oblique and meet each other at a deep entrant right-angle.

Measurements of slab specimen.	M.
Length of a series of five consecutive dorsal vertebræ.	.041
Length of second of this series	.007
Elevation " " "	.015
Length of neural spine of do.	.0065
Elevation " " " to neural canal	.009
Diameters of a vertebra without spine { vertical	.010
{ transverse	.0105
Diameters of separate centrum of do. { vertical	.003
{ transverse	.004
Length of chord of a rib; apex restored	.040
Width of shaft of do. at middle	.0035

Measurements of slab specimen.	M.
Elevation of a lumbar vertebra with spine	.017
" " spine of do	.006
Width of centrum at base of ribs	.0075
Length of rib	.0152
Diameters of a pubis { anteroposterior	.014
Diameters of a pubis { transverse	.0176
Diameters of an ischium { anteroposterior	.019
Diameters of an ischium { transverse	.012
Length of femur	.038
Diameters of shaft of femur at middle	.004
Length of tibia	.025
Diameters of tibia { proximal	.005
Diameters of tibia { at middle	.003
Diameters of tibia { distal	.0055
Width of sole, including tibia and fibula	.0125
" " intermediocalcaneum	.009
Length of " at middle	.006
" " tibiale	.007
Width " "	.005
Length " tarsale I	.0038
" " " II	.0040
" " metatarsale I	.0175
" " " II	.016
" " " III	.014
" " " IV	.012
" " " V	.009
" " second digit, minus end of unguis	.036
" " " " first phalange	.0085
" " " " second phalange	.004
" " " " third phalange	.0035
" " ten proximal caudal vertebræ	.075
Transverse extent of diapophyses of second of do	.040
Length of six distal caudal centra	.047
Depth of one centrum of do	.0037
Elevation of neural arch with spine	.0115
" " " " without spine	.003

A number of vertebræ are preserved on fragments of a softer rock of darker color than the specimen above described. It is possible that they belong to another species of the genus, as I observe some peculiarity in the caudal vertebra. The base of the neural spine is so robust as to cover the anterior section of the centrum, and does not therefore present the appearance of coming off from the posterior section alone, as is the case in the typical specimen. I have, however, not seen the arches of the anterior caudals of the latter.

A marked character of the dorsal vertebræ, is the appearance of hyperos-

tosis presented by the neural arch and its parts, and in some degree by the centrum. The outline of the latter viewed from below is barrel-shaped, and the space between the inferior surface of the centrum and the extremity of the diapophysis is filled with osseous tissue, so as to be bounded by a nearly straight line connecting the points in question. The diapophyses, where not continued into ribs, are somewhat flattened cones. The neurapophyses are greatly thickened, having more than twice the transverse diameter of the small neural canal. The zygapophyses are mere ledges; the prezygapophyses of the neurapophyses; the postzygapophyses of the neural roof. The latter is expanded and thickened, an anterior thickening on each side, constituting the zygosphen. The neural spine is moderately a little elevated, and is compressed; its base extending the length of the neural arch. The prezygapophyses are opposite the middle of the neural canal. The postzygapophyses are connected by a thin prolongation of the roof of the neural canal, which is not interrupted in any of the vertebræ at my disposal.

The anterior caudal vertebra is flattened below, and has a median shallow fossa. A large basis for a rib marks the upper part of the anterior half of the centrum, and below it is a low tuberosity. Between the latter, on the ? intercentral half, is a short accuminate tubercle directed forwards. The posterior articular face is supplemented by two facets below, as if for separate chevron bones.

A more posterior caudal vertebra has a longer, and compressed centrum, without transverse processes or tubercles. The inferior surface has a ridge on each side, which are interrupted by the constriction already mentioned. Those of the posterior half are continued into coössified chevron bones. The postzygapophyses are more elevated on the dorsal vertebræ, and the neural spine is robust and is directed strongly backwards.

The surfaces of the dorsal vertebræ are smooth; that of the anterior caudal is minutely punctate, and at some points wrinkled.

Measurements of Vertebræ.

No. 1 (with rib).	M.
Total elevation	.0125
Elevation of centrum anteriorly	.0040
" to prezygapophysis	.0055
" " zygosphen	.0070
" " highest base of neural spine	.0090
Width of centrum anteriorly	.0035
" " prezygapophyses	.0090
No. 2 (without ribs).	
Total elevation	.0160
Length of centrum	.0080
Elevation to neural canal posteriorly	.0038
" " postzygapophyses	.0058
" " neural spine	.0100

Measurements of Vertebræ.

No. 2 (without ribs).	M.
Width of centrum posteriorly	.0040
" at diapophyses inclusive	.0180
" " postzygapophyses	.0100
No. 3 (without rib).	
Diameters centrum longitudinal	.0072
Diameters centrum vertical anteriorly	.0035
Diameters centrum transverse anteriorly	.0035
Width at diapophyses inclusive	.0170
" of postzygapophyses	.0094
No. 3; posterior caudal.	
Length centrum	.0070
Width at middle	.0035
Diameters centrum in front vertical	.0040
Diameters centrum in front transverse	.0040
Elevation to postzygapophysis	.0065
Width of neural spine at postzygapophysis	.0065

This species was probably of elongate form. Prof. Derby informs me that he has seen considerable series of consecutive vertebræ. The specimens sent me indicate that the size of the body is about equal to that of the fully grown *Tejus* lizards now inhabiting Brazil.

The specimens are from four localities in the province of Sao Paolo; viz: Rio Claro, Limeria, Itapetininga and Tieté. These localities are a considerable distance apart, and represent the considerable extent of the formation from which the bones have been procured. As a Lepidodendron and a Schizodus have been obtained from the same beds, they are probably of Carboniferous or Permian age.

The specimen preserved on the slab belongs to the private collection of Madam Ribeira de Andrada, to whom science owes a debt of thanks for the opportunity of determining its characters which she has given by lending it to the Museo Nacional.

REPTILIA.

HYPOSAURUS DERBIANUS, sp. nov.

The genus Hyposaurus has been hitherto represented by but one well known species, the *H. rodgersi* Owen, of the green sand of Cretaceous No. 5, of New Jersey. Specimens in my possession demonstrate that the genus Hyposaurus belongs to the Teleosauridæ, and that its nearest ally is the Steneosaurus of St. Hilaire. It differs from Metriorhynchus Meyer, in the presence of distinct lachrymal bones, and in the relatively small size of the prefontals. From Teleosaurus proper it differs in the robust size and vertical directions of the teeth. The orbits are vertical, and the sagittal region is a keel. In the *H. rodgersi* the frontal bone is narrower than in any of the species of Teleosauridæ figured or described by

Deslongchamps. The palatal foramina extend forwards to the line of the posterior maxillary teeth, and the anterior border is rounded, not acute as in most of the species of the family.* The specimens are not sufficiently complete to enable me to state postively the generic distinction from Steneosaurus. In Teleosaurus the vertebral hypapophyses only appear on the first and second dorsal vertebræ, while, as Owen observes,† they are present on many of the dorsals in Hyposaurus. This peculiarity, and the great contraction of the frontal bone, render it very probable that the genus is distinct from Steneosaurus, but the diagnostic character yet remains to be discovered.

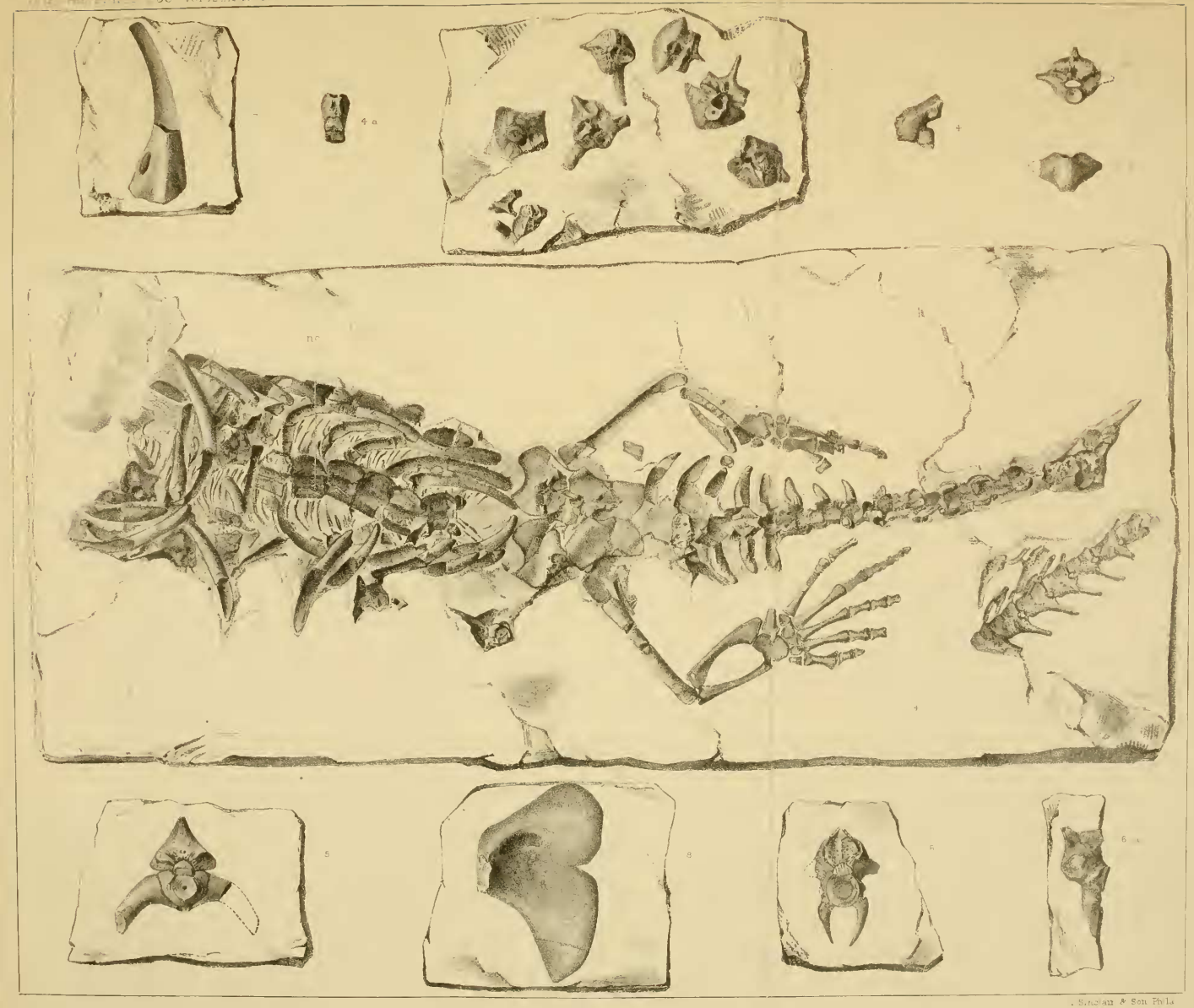
The Brazilian Hyposaurus is represented in the collection of the Museo Nacional, by the left malar and quadratojugal bones; by a nearly entire lower jaw; by several vertebræ from the middle and posterior parts of the column; by a humerus; a coracoid bone; and by several dermal bones, all belonging to one individual. There are several isolated teeth of the same animal, and others which probably belong to the same species, as they closely resemble those which are contained in the lower jaw mentioned.

The mandibular rami early unite into a long slender symphyseal portion. There are twenty alveoli in each, and only five of these are in the portion of the ramus which is posterior to the symphysis. The free portion of the ramus is compressed; both of them are broken off from the coronoid region, inclusive, posteriorly. The symphyseal region has a semicircular section, which is a little angulate; that is, is flattened laterally and below. The splenial bones appear on the inferior surface as far anteriorly as opposite to the fourth tooth from the beginning of the symphysis. The teeth have a lenticular section in the posterior part of the series, and the section becomes rounder, that of the first pair being entirely round. All display a more or less distinct cutting edge in front, and one opposite to it on the posterior face of the crown. The enamel surface is marked with rather close, straight, longitudinal ridges on the internal side of the crown. The middle of the external side is quite smooth. The crowns are acute at the apex and slightly recurved. Those of the more posterior teeth are shorter, becoming little higher than wide anteroposteriorly.

Measurements of Ramus and Teeth.		M.
Length of symphysis		.336
Width at posterior end of symphysis		.075
Depth " " "		.037
Diameters symphysis at middle	transverse	.037
	vertical	.030
Diameters at second pair of teeth	transverse	.042
	vertical	.021

* These comparisons are rendered possible by the admirable monograph of these reptiles by M. Eudes Deslongchamps in Vol. x, Bulletin Soc. Linnéenne de Normandie, 1866.

† Quarterly Journal, Geol. Society, London, 1849, p. 383.



STEREOSTERNUM TUMIDUM COPE

. Sinclair & Son Phila

Measurements of Ramus and Teeth.		M.
Diameters of base of seventh tooth from end	anteroposterior	.011
	transverse	.0085
Length of crown of a loose tooth (same animal)		.0225
Diameters middle crown of a loose tooth	anteroposterior	.080
	transverse	.050

From these measurements it is evident that the anterior extremity of the lower jaw is not expanded. The teeth of the anterior pair are directed rather more anteriorly than exteriorly. At the symphysis a horizontal figure ∞-shaped fossa marks the junction of the splenial and dentary bones, and the inferior side of the former is grooved on the middle line for 15 mm. in front of the symphysis.

The malar bone is elongate and strongly compressed, showing the great obliquity of the os quadratum. It sends upwards a postorbital branch, which is external as in other Teleosauridæ, and not internal as in Crocodilidæ. The surface is marked with shallow longitudinal fossæ like those of the lower jaw. Length from postorbital branch to quadratojugal, upper edge, .120; lower edge, .165; depth at middle, .024; thickness, .010.

In the most anterior dorsal preserved, the diapophyses are entirely on the neurapophyses. The articular faces of the centrum are shallowly concave, and the sides between them are flattened but not very concave. The hypapophysis has a long compressed base, which ceases 10 mm. anterior to the posterior extremity of the centrum. The neurapophysial suture is very little decurved in the middle. The diapophysis displays a capitular articular process, with small facet, which originates just above the suture with the centrum. The tubercular facet is at the extremity of a robust process, whose posterior edge originates near the posterior edge of the neurapophysis, and is wide at the base, enclosing a fossa. A section of the base of the diapophysis is subquadrate, with the superior or anterior angle rounded, and the inferior anterior produced downwards and forwards for the base of the capitular portion, like the tail of a comma. The general form of the tubercular part of the diapophysis is subconical. A convexity proceeds from its anterior base, its continuation forming the lateral convex face of the prezygapophysis. The latter is small, and its superior or articular face is on a level with the roof of the neural arch, thus having a rather low position. The arch rises steeply to the neural spine. The latter is moderately elevated, and is much compressed and thin, having a narrow anterior edge, and a posterior edge not quite so narrow. The summit is not thickened, as is the case in *Teleosaurus cadomensis*, according to Deslongchamps, and is wide anteroposteriorly. Both anterior and posterior edges of the spine are a little thickened, and are medially grooved for a short distance above the neural canal. The neural canal is ample, and is a little wider than high at its anterior extremity.

In a dorsal vertebra near that last described in the series, the capitular part of the diapophysis is carried nearer to the tubercular portion, and the base of the two combined is less robust, the section having an elon-

gate triangular outline, the base anterior. The capitular portion is still decurved so as to present below the tubercular, and is narrow. The prezygapophyses are small. The postzygapophyses are close together, and are separated by a deep groove. The articular faces are shallowly and equally concave, and are vertical to the long axis of the centrum. The hypapophysis occupies the anterior three-quarters of the middle line of the centrum.

In a dorsal posterior to the one last described, the diapophysis is still more depressed at the base, which is oblique to the long axis by about 25°. The postzygapophyses are concave on their articular faces, the concavity extending as a shallow groove to the posterior base of the diapophysis. They are separated by a vertical groove of the base of the neural spine still deeper than in the vertebra last described. The centrum is less compressed than in those more anterior, and there is not even a keel to represent the hypapophysis. The neural spine is less elevated than in the other dorsals described, and its summit is rounded off in front, and is compressed. The dorsal which precedes this one in the series is represented by a centrum only. This has an inferior median angle representing the hypapophysis.

An anterior caudal has a diapophysis of medium length, depressed, and when viewed from above, displaying an outline of an elongate cone with truncate apex. The zygapophyses are fairly well developed, and the neural spine is large, especially anteroposteriorly. The chevron facets are large and close together. The median line of the inferior face of the centrum is concave. The articular faces of the centrum are slightly concave, and the anterior is deeper than wide.

Measurements of Vertebræ.	M.
Total elevation of No. 1	.114
Diameters of centrum posteriorly { vertical	.035
transverse	.039
Diameters neural canal posteriorly { vertical	.027
transverse	.023
From centrum to face of postzygapophysis	.031
Length centrum at base neural canal	.048
Anteroposterior width neural spine above postzygapophyses	.040
Diameters centrum dorsal No. 2 { anteroposterior	.049
vertical (front)	.037
transverse (front)	.038
Length diapophysis from base, below	.038
Width at postzygapophyses, inclusive	.030
Diameters of dorsal No. 4 { anteroposterior	.048
vertical (behind)	.040
transverse (behind)	.040
Diameters neural canal posteriorly { vertical	.015
transverse	.018

Measurements of Vertebræ.	M.
Elevation neural spine from canal	.054
Length diapophysis below	.038
Width at postzygapophyses	.030
Diameters of a caudal vertebra: anteroposterior	.045
Diameters of a caudal vertebra: vertical (front)	.037
Diameters of a caudal vertebra: transverse (front)	.035
Length diapophysis below	.033
Width at postzygaphyses	.023
Length of base neural spine above postzygapophyses	.030

The coracoid bone has an expanded proximal extremity, which contracts on the external side abruptly, into a slender shaft which continues to the distal end, which is but little expanded. The coracoid foramen is well within the external border, and is small. The distal end is flattened below, and has a convex margin. The shaft has an oval section. This element is much more slender than in the *Alligator mississippiensis*, and even more so than in the *Teleosaurus cadomensis*, according to Deslongchamps.

Measurements of Coracoid.	M.
Total length	.165
Long diameter of proximal end	.065
Thickness of proximal end at glenoid facet	.023
Diameter of shaft: vertical	.010
Diameter of shaft: transverse	.015
Width of distal end	.0295

The humerus is rather elongate, and is but little curved. The head is directed a little inwards and forwards, and the condyles (which are lost) a little backwards. The section of the shaft is nearly round from below the deltoid crest to near the condyles. The head is flattened and its articular extremity is convex and narrow. Near the internal border of the anterior side is a shallow fossa. The deltoid crest is elongate, and lies on the external edge of the posterior face. Its elevation increases distal, *i. e.*, to a point nearly two-fifths the length from the head.

Measurements of Humerus.	M.
Length of part preserved	.220
Diameters of head: anteroposterior	.019
Diameters of head: transverse	.051
Diameters shaft 3 c.m. below crest: anteroposterior	.025
Diameters shaft 3 c.m. below crest: transverse	.027

General Remarks.—The characters of this species are much like those of *H. rodgersi*, so far as they are known. I observe the following differences on comparison with several individuals of that species. The articular faces of the vertebral centra, are less concave than in the Northern species. The symphyseal part of the mandible is a part of a cylinder in the *H. rodgersi*, while it is flattened below and at the sides in the Brazilian

species. The bones of the limbs are relatively less robust in the *H. derbianus.** The differences, especially in the humerus, are well marked.

I name this species in honor of Prof. Orville A. Derby, in charge of the department of Geology in the Museo National of Brazil.

MAMMALIA.

TOXODON EXPANSIDENS sp. nov.

The incisors of the first and second places of the upper jaw, represent this species. Comparison with the corresponding teeth of the known species, reveals well-marked distinctive characters.

The incisor of the median pair has greater transverse, and less anteroposterior, diameter than in any of the known species. Its diameters are uniform. The cutting edge is five and a half times as long transversely as it is anteroposteriorly. The anterior enameled face has two planes, a wide exterior one which is concave, and a narrower inner one which retreats inwards, and is plane to the convex inner (median) edge. The enamel extends round the narrow external edge, but disappears at the middle of the inner beveled faces. The angle between the two faces forms a rib, parallel with the borders of the tooth. No enamel on the internal face. Enamel surface with rather coarse obsolete longitudinal grooves.

The external incisor is a robust, prismatic, rodent-like tooth, strongly curved. Its section is triangular, the posterior (enameled) face being convex. The external face is flat, and its plane forms less than a right angle with the anterior face, from which it is separated by a convex intermediate surface. The prominence of the latter causes the anterior face to be slightly concave. The angle is the most prominent portion of the cutting edge. The enamel ceases a little short of the narrow internal edge of the tooth ; its surface is marked with obsolete longitudinal grooves.

Measurements of Teeth.			M.
First incisor.			
Diameters of crown	vertical		.080
	transverse		.059
	anteroposterior	at middle	.011
		at angle	.015
Width of internal level			.022
Second incisor.			
Diameters of tooth	vertical on curve		.150
	transverse		033
	anteroposterior (externally)		.021

This species is as large as the *Toxodon platensis* Owen. As compared with that animal, the median incisors have much greater transverse extent, and relatively smaller anteroposterior diameter. These teeth are

*For figures of humerus and femur of *H. rodgersi*, see Transac. Amer. Philos. Soc. xiv, Pl. iv, figs. 10–11, 1879.

still more different from those of *T. burmeisteri*. The external incisors are, on the other hand, more like those of the latter species in their triangular form, though their inner angle is not produced as in that species.

Explanation of Plate.

The figures represent the *Stereosterum tumidum* in various pieces ; all of the natural size excepting fig. 1, which is three-fourths natural size.

Fig. 1. The typical specimen on a slab of calcareous shale of the carboniferous formation ; the anterior part of the skeleton wanting ; viewed from below. *nc*, notochordal canal exposed by the splitting of the vertebral centrum.

Fig. 2. Vertebræ in a piece of weathered rock of darker color than the slab.

Fig. 3. A lumbar vertebra from the piece of matrix represented in fig. 2, anterior view ; *a*, inferior view

Fig. 4. A caudal vertebra from the same piece of stone, left side ; *a*, inferior side.

Fig. 5. A dorsal vertebra with proximal portions of ribs embracing the centrum ; from a different piece of matrix.

Fig. 6. A vertebra of uncertain position, with descending processes, anterior view ; *a*, the same lateral view.

Fig. 7. Humerus, the proximal portion represented by a mould ; from a separate piece.

Fig. 8. Coracoid bone from a separate piece.

All the specimens are preserved in Museo Nacional of Rio Janeiro, excepting that represented in fig. 1, which is in the collection of Madame Ribeira de Andrada.

Some new Hypotrichous Infusoria. By Dr. Alfred C. Stokes.

(*Read before the American Philosophical Society, June 19, 1885.*)

Wet Sphagnum seems to be a favorite haunt for certain fresh-water protozoa. Dr. Leidy found it an unfailing source of supply for many of the Rhizopoda, some of the most interesting forms described by that illustrious naturalist being obtained from a little bunch of the moss. In my own vicinage the beautiful plant is comparatively rare, but a single marsh of not extended dimensions does happily exist here, with the pale Sphagnum in some abundance greenly glimmering beneath the shallow water, while the shadows of elder, azalea and serviceberry, and the broad leaves of tangled smilax vines make the neighboring thicket dim and cool even when the hot sun smites the furrowed field that borders it. Among these pleasing surroundings the Rhizopoda are in numbers excelled only by the Infusoria, as the following previously undescribed forms testify. And it is